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No. 51—1913.

British Engineering Standards Association.

(Incorporated 1918.)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE
BY
THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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BRITISH STANDARD SPECIFICATION FOR WROUGHT IRON

FOR USE IN RAILWAY ROLLING STOCK.

"BEST-YORKSHIRE" AND GRADES A, B, AND C.

(REVISED AUGUST, 1913.)

LONDON:
PUBLISHED FOR THE ASSOCIATION BY CROSBY LOCKWOOD & SON,
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The Institution of Civil Engineers.
The Institution of Mechanical Engineers.
The Institution of Naval Architects.
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BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are lists of Members of the Sectional Committees on Locomotives and on Railway Rolling Stock Underframes, and of the Sub-Committee on Iron for Railway Rolling Stock which was entrusted with the drafting of the following Specification :—

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* Succeeded Mr. A. Brereton, C.S.I., April, 1913.
† Since deceased.

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† Since deceased.

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August, 1913.

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† Since deceased.

PREFACE TO FIRST EDITION.

The Sectional Committee on Locomotives was appointed at the Meeting of the Main Committee held on April 16th, 1902, and the Sectional Committee on Railway Rolling Stock Underframes at the Meeting of the Main Committee held on July 16th, 1901.

The question of recommending Standards for Wrought Iron for use in Railway Rolling Stock having been brought to the notice of the Sectional Committees on Locomotives and on Railway Rolling Stock Underframes, the Sub-Committee on Wrought Iron for use in Railway Rolling Stock was appointed at a joint meeting of the two above-mentioned Sectional Committees held on May 31st, 1907, and the appointment was confirmed by the Main Committee at their Meeting on June 6th, 1907.

The Sub-Committee in classifying the various grades of iron did not consider it desirable to perpetuate such terms as "*Treble Best*," "*Best Best*," or "*Best*" as applied to Staffordshire Iron. They were of opinion that it was preferable to indicate the best practice by suitable tests for each grade of iron rather than to perpetuate the use of trade expressions which have in most cases ceased to possess their original meaning. The Sub-Committee consider that four grades will meet all general requirements for Wrought Iron for use in Railway Rolling Stock, and they have accordingly recommended that the Standard grades be known as "Best-Yorkshire," Grade "A," Grade "B," and Grade "C."

This Report was adopted by the Sectional Committees on Locomotives and on Railway Rolling Stock Underframes at their Joint Meeting held on July 20th, 1910.

This Report was approved by the Main Committee at their Meeting held on July 22nd, 1910.

PREFACE TO FIRST REVISION.

Since the first issue of the Specification in August, 1910, the Committee have from time to time had brought before them points which had arisen in connection with its use, and the present issue embodies the Committee's decisions in regard to these. Some of the more important modifications to the Specification are as follows:—

1. A reduction in the number of tensile tests for Best-Yorkshire Bar Iron.
2. A similar reduction in the number of Bend Tests for Best-Yorkshire Bar Iron other than Staybolt, Rivet and Stud Iron.
3. The deletion of the Quenching Test for Best-Yorkshire Iron.
4. The inclusion under Grade B of the tests for Plates which were included under Grade C in the previous issue, but with a slightly increased minimum elongation per cent. and somewhat more severe bend tests, and the insertion under Grade C of Plates of Cleveland Iron Quality.

5. An increase in the Minimum Contraction of Area per cent. of Original Area for Grade **A** Round and Square Bars up to $1\frac{1}{2}$ inches diameter or side.

6. An increase in the Minimum Contraction of Area per cent. of Original Area for Grade **B** Round and Square Bars up to $1\frac{1}{4}$ inches diameter or side.

7. The optional use of Standard Test Pieces **B** or **F** for Angles, Flat Bars and other pieces exceeding 1 inch in thickness.

8. The provision of Bend Test Pieces for Blooms and Billets, for bars over $2\frac{1}{2}$ inches diameter or side, and for Flats over 1 inch thick.

9. The provision for testing Blooms, Billets and pieces of finished iron exceeding 16 square inches in sectional area by drawing down the material into a bar of $2\frac{1}{2}$ inches square or of $2\frac{1}{2}$ inches diameter, and testing the material for compliance with the requirements of the tensile tests for Rounds and Squares of $2\frac{1}{2}$ inches diameter or side.

10. The deletion from the Tables of Tensile Tests of the requirements for round or square bars above 4 inches in diameter or side, as these are covered by the preceding amendment.

11. The addition of a Quenching Test for Grade **B**.

The Specification in its present form was approved by the Sectional Committees on Locomotives and Railway Rolling Stock Underframes at their meeting on July 1st, 1913, and by the Main Committee at their meeting on July 17th, 1913.

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH

STANDARD SPECIFICATION

FOR

WROUGHT IRON

FOR USE IN RAILWAY ROLLING STOCK.

(REVISED AUGUST, 1913.)

GENERAL CLAUSES.

Classification of Iron.

1. Wrought Iron for Railway Rolling Stock shall be either of "Best-Yorkshire" or of Grades **A**, **B** or **C**, in accordance with the purpose for which it is to be used, as specified by the Engineer (or by the Purchaser).

Quality of Material.

2. The whole of the iron supplied is to be of the description known as "puddled" wrought iron. In no case will steel be allowed to be used as a mixture, and its presence in any specimens under this specification will involve the rejection of the material represented.

Freedom from Defects.

3. The Plates, Bars, Angles, and other Sections must be well and cleanly rolled to the dimensions and sections specified, and must be sound and free from flaws, cracks, crop ends and defects of any description. Any Bars, Angles, or other sections which do not hold up to the full dimensions from end to end, or which have rough, jagged, or imperfect edges or ends will be rejected.

Rolling Margin.

4. No Bars, Angles, or other Sections must be more than $2\frac{1}{2}$ per cent., and no Plate $\frac{1}{4}$ inch thick or over must be more than 5 per cent., above or below the calculated weight. In the case of Boiler Plates, no plate must be under, nor more than 5 per cent. over, the calculated weight.

Hot Straightening.

5. All Bars, Angles, and other Sections shall be hot straightened before cooling, but, unless otherwise distinctly specified in the enquiry, they shall not be liable to rejection on account of any want of straightness due to their warping in the process of cooling.

Cold Straightening.

6. Where Bars, Angles, and other Sections are required to be specially cold straightened, for direct use in constructional or other work, this requirement shall be distinctly specified in the enquiry. Such cold straightening shall be done by pressure and not by hammering.

Lengths of Bars.

7. Bars, Angles, and other Sections destined for stock may be 1 foot under or over the specified "average" lengths. When ordered to be cut hot to specified lengths, by means of hot saws or at the shears, a margin of 1 inch over or 1 inch under the specified length shall be allowed. In case the Bars, Angles, or other Sections are required to be nothing under the specified length, a margin of 2 inches over shall be allowed. When Bars, Angles, and other Sections are ordered to "dead lengths" they shall first be cold straightened, and afterwards cold sawn or otherwise machined to the length specified, but a margin of $\frac{1}{8}$ inch over shall be allowed.

Selection of Test Pieces.

8. All test pieces shall be selected by the Inspector * and tested in his presence.

Tensile Test Pieces.

9. The tensile strength and elongation shall be determined from Standard Test Pieces cut lengthwise and crosswise from Plates and lengthwise from Bars, Angles and other Sections. Any straightening of test pieces which may be required shall be done cold.

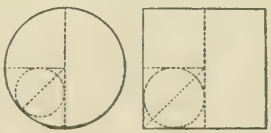
For Plates, Flats, Angles, and Sections other than Rounds and Squares the Standard Test Piece having a gauge length of 8 inches (Test Piece **A,** *see* Appendix, page 25) shall be used. Where Angles, Flats and other Sections exceed 1 inch in thickness, Standard Test Pieces **B,** or **F** (*see* Appendix, pages 26 and 27) may be used.

For Round and Square Bars a Standard Test Piece having a gauge length of 8 times the diameter (Test Piece **B,** *see* Appendix,

* The word "Inspector" shall include any person acting under the express written authority of the Engineer (or of the purchaser).

page 26) shall be used. Where bars are $1\frac{1}{4}$ inches in diameter and over, and are tested full size as rolled, or have been turned down, and the resulting test piece is above 1 inch in diameter, a Standard Test Piece having a gauge length of not less than 4 times the diameter (Test Piece **F,** *see* Appendix, page 27) may be used.

For Billets and Blooms and for pieces of finished bar iron exceeding 16 square inches in sectional area and over $2\frac{1}{2}$ inches in thickness, the test piece shall be provided in the following manner :— A specimen of the material shall be drawn down under the hammer, or rolled in a hot state into a round or square bar of suitable length having a diameter or side measuring $2\frac{1}{2}$ inches. From this bar a Standard Test Piece above 1 inch in diameter and having a gauge length of not less than four times the diameter (Test Piece **F,** *see* Appendix, page 27) shall be used, and tested to the requirements for bars of $2\frac{1}{2}$ inches diameter or side.



The rolled surface of the Iron wherever practicable, shall be retained on two opposite sides of the test piece, but in the case of Bars having diameters or sides not exceeding $2\frac{1}{2}$ inches, and the specimens from Billets, Blooms and Bars obtained in the manner above referred to, the material may be reduced by turning. For bars having diameters or sides above $2\frac{1}{2}$ inches the test piece may, at the option of the maker, be taken from the position shown in the sketches.

Should a tensile test piece break outside the middle half of its gauge length, the test may, at the Maker's option, be discarded, and another test be made of the same plate or bar.

Bend Test Pieces.

10. Bend Test Pieces shall be sheared or cut with or across the grain from plates and lengthwise from Bars, Angles and other Sections, and shall be not less than $1\frac{1}{2}$ inches in width or diameter as the case may be, but for small Round, Square or Flat Bars under $1\frac{1}{2}$ inches in width or diameter, pieces cut from the bar as rolled may be used. For Bars, Sections or pieces over $2\frac{1}{2}$ inches in thickness or diameter, and not exceeding 16 square inches in sectional area, the test pieces shall be machined down to $2\frac{1}{2}$ inches square or diameter, and, at the option of the Maker, may be taken from the position shown in the sketches attached to Clause 9. In the case of "half-worked" material, such as blooms and billets and of pieces of finished bar iron exceeding 16 square inches in

sectional area and over $2\frac{1}{2}$ inches in thickness, the test pieces shall be provided by drawing down the material under the hammer or by rolling in a hot state into a round or square bar of suitable length, having a diameter or side measuring $2\frac{1}{2}$ inches.

Additional Tests before Rejection.

11. Should either a tensile or bend test fail to fulfil the test requirements, and the Inspector agrees that the test piece does not fairly represent the quality of the material, two duplicate specimens may, if the Maker wishes, be tested, and if the results obtained from both are satisfactory, the quality of the material shall be judged therefrom and not from the original test which failed. If, however, either of the duplicate tests fails, the material represented should be rejected.

Independent Tests.

12. Although fulfilling the mechanical tests of the Specification, any iron which, from the appearance of the fracture or behaviour under tests, is not considered by the Engineer to be in accordance with the Specification, may be subjected to such further proofs as the Engineer may decide, to be made by an independent authority to be mutually agreed upon. The expenses attendant upon such independent testing shall be borne by the party adjudged to be in the wrong.

Inspection.

13. The Engineer, the Purchaser, and the Inspector shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage and to reject any material that does not conform to the terms of this Specification.

Testing Facilities.

14. The Manufacturer shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests the Manufacturer shall bear the cost of carrying out the tests elsewhere.

"BEST-YORKSHIRE."

(BARS, BILLETS, BLOOMS AND PLATES.)

Manufacture.

15. "Best-Yorkshire" iron shall be manufactured by a recognised "Best-Yorkshire" iron firm.

Tensile Tests.

16. The iron dealt with under this grade shall comply with the tensile tests set forth in Table I.

BARS, BILLETS AND BLOOMS.

Number of Tensile Tests.

17. One tensile test shall be taken from every three tons or portion thereof in each batch of any order presented for inspection in the case of material over 1¼ inches in thickness or diameter.

Two tensile tests shall be taken from every three tons or portion thereof in each batch of any order presented for inspection, in the case of material of 1¼ inches in thickness or diameter and under, except that in the case of lots of one ton or less one tensile test shall be accepted.

Nicked Bend and Fracture Tests.

18. Test pieces provided in accordance with Clause 10 shall be lightly and evenly nicked on one side with a sharp cutting tool, and bent back at this point through an angle of 180 degrees by pressure in a press, or by a succession of light blows, when they shall show a fibrous fracture free from slag or dirt. The same test pieces when nicked all round and broken off short shall show a fine uniform crystalline fracture.

Cold Bend Tests.

19. *Round, Square and Flat Bars*:—For Round Bars other than Staybolt, Rivet and Stud Iron, and for Square and Flat Bars, test pieces under 2 inches in diameter or thickness, provided in accordance with Clause 10, must withstand being bent cold flat on themselves without sign of fracture. Test pieces 2 inches in diameter or thickness and up to 2½ inches inclusive must withstand being bent cold through an angle of 180 degrees by pressure, or by a succession of light blows, over a round bar equal in diameter to the diameter or thickness of the test piece without showing signs of fracture on the outside of the bent portion.

Cold Bend Test for Staybolt, Rivet and Stud Iron.

20. *Staybolt, Rivet and Stud Iron*:—A piece of about 24 inches long must withstand being bent cold in the middle through 180 degrees flat on itself, and then being bent in the middle through 180 degrees flat on itself in a plane at a right angle with

the former direction, as indicated in the sketch, without showing signs of fracture on the outside of the bent portions.

Number of Bend Tests.

21. One cold and two nicked bend tests, and two fracture tests, shall be taken from each three tons of material or portion thereof in each batch of any order presented for inspection. In the case of Staybolt, Rivet and Stud Iron, the above tests shall be taken from each ton of material or portion thereof in each batch of any order presented for inspection.

PLATES.

(This Specification does not apply to Boilers.)

Number of Tensile Tests.

22. For orders containing 10 plates as rolled and under, not more than 3 plates as rolled shall be subjected to tensile tests; for over 10 and up to 30, not more than 4 plates; for over 30 and up to 50, not more than 5 plates; for over 50 plates, 10 per cent. In no case shall there be less than one tensile test for each thickness of plate on order, however small the quantity. A tensile test shall consist of one with and one across the grain.

Cold Bend Tests.

23. Pieces not less than $1\frac{1}{2}$ inches wide, sheared from the plates and ground on the edges, must withstand being bent cold to the following radius and the ends brought together without showing signs of fracture:—

With the Grain.—To an internal radius equal to the thickness of the test piece.

Across the Grain.—To an internal radius equal to twice the thickness of the test piece.

Number of Bend Tests.

24. One cold bend test shall be taken from suitable strips cut from shearings from each plate as rolled.

GRADE A.

(BARS, BILLETS AND BLOOMS ONLY.)

Tensile Tests.

25. The iron dealt with under Grade **A** shall comply with the tensile tests set forth in Table II.

Number of Tensile Tests.

26. One tensile test shall be taken from every three tons or portion thereof in each batch of any order presented for inspection in the case of material over $1\frac{1}{4}$ inches in thickness or diameter.

Two tensile tests shall be taken from every three tons or portion thereof in each batch of any order presented for inspection in the case of material 1¼ inches in thickness or diameter and under, except that in the case of lots of one ton or less one tensile test shall be accepted.

Nicked Bend Test.

27. Test pieces provided in accordance with Clause 10 shall be lightly and evenly nicked on one side with a sharp cutting tool, and bent back at this point through an angle of 180 degrees by pressure in a press, or by a succession of light blows. They shall show a clean silky fibre, free from slag or dirt or any coarse crystalline spots.

Cold Bend Test.

28. Test pieces provided in accordance with Clause 10 must withstand being bent cold through an angle of 180 degrees by pressure, or by a succession of light blows, over a round bar equal in diameter to the diameter or thickness of the test piece, without showing signs of fracture on the outside of the bent portion.

Hot Bend Test.

29. A test piece, provided in accordance with Clause 10, and heated to a bright red (1,700° to 1,800° Fahr.) must withstand, without showing signs of cracks or flaws, being bent flat on itself by pressure, or by a succession of light blows, without hammering directly on the bend.

Quenching Test.

30. A test piece, provided in accordance with Clause 10, heated to a yellow heat (1,900° to 2,000° Fahr.) and suddenly quenched in water having a temperature not exceeding 90° Fahr. must withstand, without showing cracks or flaws, being bent through an angle of 180 degrees over a bar equal in diameter to the diameter or thickness of the test piece, without hammering directly on the bend.

Number of Bend Tests.

31. One hot, one cold, and two nicked bend tests and one quenching test shall be taken from each ton of material or portion thereof in each batch of any order presented for inspection.

Ram's Horn Test.

32. Specimens of the bars as rolled shall be punched at a full red heat (1,500° to 1,600° Fahr.), with a punch one-third the diameter or width of the bar, at a distance from the end of the bar

equal to one and one half ($1\frac{1}{2}$) times the diameter or width (Fig. 1). The hole shall then be drifted out to one and one quarter ($1\frac{1}{4}$) times the diameter or width of the bar (Fig. 2). The end of the bar up to the hole shall then be split, and the ends must admit of turning back without fracture (Fig. 3).

FIG. 1.

FIG. 2.

FIG. 3.

Any extension of the original split or indications of fracture, cracks, or flaws developed by the above tests will be sufficient cause for the rejection of the lot represented by the bar tested.

Number of Ram's Horn Tests.

33. One Ram's Horn test shall be taken from each size of bar or from each 5 tons of material, whichever method gives the smaller number of test pieces.

Welding Test.

34. A specimen shall be worked and welded in the smithy without showing sign of redshortness.

Number of Welding Tests.

35. One welding test shall be taken from each size of bar or from each 5 tons of material, whichever method gives the smaller number of test pieces.

GRADE B.

(BARS, BILLETS, BLOOMS AND PLATES.)

Tensile Tests.

36. The iron dealt with under Grade **B** shall comply with the tensile tests set forth in Table III.

BARS, BILLETS AND BLOOMS.

Number of Tensile Tests.

37. One tensile test shall be taken from every three tons or portion thereof in each batch of any order presented for inspection in the case of material over $1\frac{1}{4}$ inches in thickness or diameter.

Two tensile tests shall be taken from every three tons or portion thereof in each batch of any order presented for inspection in the case of material $1\frac{1}{4}$ inches in thickness or diameter and under, except that, in the case of lots of 1 ton or less, one tensile test shall be accepted.

Nicked Bend Test.

38. Test pieces provided in accordance with Clause 10 shall be lightly and evenly nicked on one side with a sharp cutting tool,

and bent back at this point through an angle of 180 degrees by pressure in a press, or by a succession of light blows. They shall show a clean fibrous fracture, free from slag or dirt or any coarse crystalline structure.

Cold Bend Test.

39. Test pieces provided in accordance with Clause 10 must withstand being bent cold through an angle of 180 degrees by pressure, or by a succession of light blows, over a round bar equal in diameter to $1\frac{1}{2}$ times the diameter or thickness of the test piece without showing signs of fracture on the outside of the bent portion.

Hot Bend Test.

40. A test piece provided in accordance with Clause 10 and heated to a bright red (1,700° to 1,800° Fahr.) must withstand, without showing signs of cracks or flaws, being bent flat on itself by pressure or by a succession of light blows, without hammering directly on the bend.

Quenching Test.

41. A test piece, provided in accordance with Clause 10, heated to a yellow heat (1,900° to 2,000° Fahr.), and suddenly quenched in water having a temperature not exceeding 90 degrees Fahr., must withstand, without showing cracks or flaws, being bent through an angle of 180 degrees over a bar equal in diameter to the diameter or thickness of the test piece, without hammering directly on the bend.

Number of Bend Tests.

42. One hot, one cold, and two nicked bend tests and one quenching test shall be taken from each ton of material or portion thereof in each batch of any order presented for inspection.

Ram's Horn Test.

43. Specimens of the bars as rolled shall be punched at a full red heat (1,500° to 1,600° Fahr.), with a punch one-third the diameter or width of the bar, at a distance from the end of the bar equal to one and one half ($1\frac{1}{2}$) times the diameter or width (Fig. 1). The hole shall then be drifted out to one and one quarter ($1\frac{1}{4}$) times the diameter or width of the bar (Fig. 2). The end of the bar up to the hole shall then be split, and the ends must admit of turning back without fracture (Fig. 3).

FIG. 1.

FIG. 2.

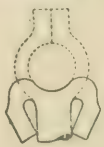


FIG. 3.

Any extension of the original split or indications of fracture, cracks, or flaws developed by the above tests will be sufficient cause for the rejection of the lot represented by the bar tested.

Number of Ram's Horn Tests.

44. One Ram's Horn test shall be taken from each size of bar, or from each 5 tons of material, whichever method gives the smaller number of test pieces.

Welding Test.

45. A specimen shall be worked and welded in the smithy without showing signs of redshortness.

Number of Welding Tests.

46. One welding test shall be taken from each size of bar, or from each 5 tons of material, whichever method gives the smaller number of test pieces.

PLATES.

Number of Tensile Tests.

47. One tensile test shall be taken from every five plates as rolled. A tensile test shall consist of one with and one across the grain.

Cold Bend Test.

48. Pieces of plate must withstand being bent cold, according to thickness, through the following angles without showing signs of fracture :—

Thickness of Plate	1¼	⅝	½	⅜	¼	⅞ in.
With the grain	80	58	42	32	25	22 deg.
Across the grain	35	25	17	13	10	8 deg.

All bends to be made over a round bar of not more than one inch in diameter.

Hot Bend Test.

49. Pieces of plate one inch thick and under heated to a bright red (1,700° to 1,800° Fahr.) must withstand being bent through an angle of 125 degrees with the grain, and 100 degrees across the grain without showing signs of fracture over a round bar of not more than one inch in diameter.

Number of Bend Tests.

50. One hot and one cold bend test shall be taken from suitable strips cut from shearings from each plate as rolled.

GRADE C.

(BARS AND PLATES.)

Tensile Tests.

51. The iron dealt with under Grade **C** shall comply with the tests set forth in Table IV.

BARS.

Number of Tensile Tests.

52. One tensile test shall be taken from every 3 tons or portion thereof in each batch of any order presented for inspection in the case of material over $1\frac{1}{4}$ inches in thickness or diameter.

Two tensile tests shall be taken from every 3 tons or portion thereof in each batch of any order presented for inspection in the case of material $1\frac{1}{4}$ inches in thickness or diameter and under, except that, in the case of lots of 1 ton or less, one tensile test shall be accepted.

Nicked Bend Test.

53. Test pieces provided in accordance with Clause 10 shall be lightly and evenly nicked on one side with a sharp cutting tool, and bent back at this point through an angle of 180 degrees by pressure in a press or by a succession of light blows. They shall show a clean fibrous fracture, free from slag or dirt or any coarse crystalline structure.

Cold Bend Test.

54. Test pieces provided in accordance with Clause 10 from all round or square bars, and flats up to $1\frac{1}{4}$ inches thick, must withstand being bent cold through an angle of 90 degrees by pressure, or by a succession of light blows over a round bar equal in diameter to $1\frac{1}{2}$ times the diameter or thickness of the test piece without showing signs of fracture on the outside of the bent portion. Flats over $1\frac{1}{4}$ inches thick must withstand being bent cold through an angle of 135 degrees over a round bar equal in diameter to twice the thickness of the test piece without showing signs of fracture on the outside of the bent portion.

Hot Bend Test.

55. A test piece provided in accordance with Clause 10 and heated to a bright red (1,700° to 1,800° Fahr.) must withstand, without showing signs of cracks or flaws, being bent flat on itself by pressure, or by a succession of light blows without hammering directly on the bend.

Number of Bend Tests.

56. One hot, one cold, and one nicked bend test shall be taken from each ton of material or portion thereof in each batch of any order presented for inspection.

PLATES.

Number of Tensile Tests.

57. One tensile test shall be taken from every five plates as rolled. A tensile test shall consist of one with and one across the grain.

Cold Bend Test.

58. Pieces of plate must withstand being bent cold, according to thickness, through the following angles without showing signs of fracture :—

Thickness of Plate	¼	⅜	½	⅝	¾	⅞ in.
With the grain	70	50	35	27	21	17 deg.
Across the grain	30	20	15	12	10	7 deg.

All bends to be made over a round bar of not more than one inch in diameter.

Hot Bend Test.

59. Pieces of plate one inch thick and under heated to a bright red (1,700° to 1,800° Fahr.) must withstand being bent through an angle of 125 degrees with the grain and 90 degrees across the grain, without showing signs of fracture over a round bar of not more than one inch in diameter.

Number of Bend Tests.

60. One hot and one cold bend test shall be taken from suitable strips cut from shearings from each plate as rolled.

TABLE I.

TENSILE TESTS FOR WROUGHT IRON.

"BEST—YORKSHIRE."

Section.	Dimensions.	Tensile Strength, Tons per sq. in.	Minimum Elongation per cent.				Minimum Contraction of Area per cent. of Original Area.	Minimum Yield Point per cent. of Tensile Strength.
			Test Piece B.		Test Piece F.			
	Diameters or Sides up to :—		As Rolled.	Turned Down.	As Rolled.	Turned Down.		
ROUNDS AND SQUARES.	⅜ in.	22 to 25	27	—	—	—	54	56
	9/16 in....	22 to 25	28	—	—	—	54	56
	¾ in.	21 to 24	29	—	—	—	54	56
	1 in.	21 to 23½	29	27	—	—	54	56
	1¼ ins.	21 to 23½	29	27	38	36	53	56
	1½ ins.	21 to 23½	29	27	36	34	51	56
	2 ins.	21 to 23½	—	26	—	33	48	56
	2½ ins.	21 to 23½	—	25	—	30	45	50
	3 ins.	21 to 23½	—	24	—	28	43	50
	3½ ins.	21 to 23½	—	23	—	27	42	50
	4 ins.	21 to 23½	—	22	—	26	41	50
			Test Piece A.					
FLATS. NOTE. Flats over 1 inch thick shall comply with the tests applicable to a square bar having a side equal to the mean of the two adjacent sides of the Flat.	4 ins. wide and under, tested as rolled or machined to 1½ ins. wide × under 5/16 in. thick	21 to 24	24				40	50
	Ditto × 5/16 in. to under ½ in. thick...	21 to 24	25				42	50
	Ditto × ½ in. thick and over up to 1 in. thick inclusive ...	21 to 24	26				44	50
	Over 4 ins. wide, tested as rolled or machined to 1½ ins. wide. × ½ in. thick and under	21 to 24	24				40	50
	Ditto × over ½ in. thick up to and including 1 in. thick.	21 to 24	25				42	50
ANGLES AND TEES.	½ in. thick and under	21 to 24	24				40	50
	Over ½ in. thick ...	21 to 24	24				40	50
PLATES. With the grain.	¼ in. to ⅞ in. thick	21 to 24	17				—	—
Across the grain.	¼ in. to ⅞ in. thick	20 minimum.	12				—	—

NOTE: 1 TON = 2,240 LBS.

TABLE II.

TENSILE TESTS FOR WROUGHT IRON.

GRADE A.

Section.	Dimensions.	Tensile Strength, Tons per sq. in.	Minimum Elongation per cent.				Minimum Contraction of Area per cent. of Original Area.
			Test Piece B.		Test Piece F.		
			As Rolled.	Turned Down.	As Rolled.	Turned Down.	
	Diameters or Sides up to:—						
ROUNDS AND SQUARES.	⅜ in.	21 to 25	25	—	—	—	50
	9/16 in.	21 to 25	25	—	—	—	50
	¾ in.	21 to 25	28	—	—	—	48
	1 in.	21 to 25	28	25	—	—	47
	1¼ ins.	21 to 24	28	25	35	33	46
	1½ ins.	21 to 24	28	25	34	32	46
	2 ins.	21 to 24	—	24	—	31	43
	2½ ins.	20 to 24	—	23	—	28	42
	3 ins.	20 to 24	—	22	—	26	41
	3½ ins.	20 to 24	—	21	—	25	40
	4 ins.	20 to 24	—	20	—	24	38
			Test Piece A.				
FLATS. NOTE. Flats over 1 inch thick shall comply with the tests applicable to a square bar having a side equal to the mean of two adjacent sides of the Flat.	4 ins. wide and under, tested as rolled or machined to 1½ ins. wide × under 5/16 in. thick	21 to 24	22				36
	Ditto × 5/16 in. to under ½ in. thick...	21 to 24	23				38
	Ditto × ½ in. thick and over up to 1 in. thick inclusive ...	21 to 24	24				40
	Over 4 ins. wide, tested as rolled or machined to 1½ ins. wide. × ½ in. thick and under	21 to 24	22				36
	Ditto × over ½ in. thick up to and including 1 in. thick	21 to 24	23				38
ANGLES, TEES, AND CHANNELS.	½ in. thick and under	21 to 24	18				27
	Over ½ in. thick ...	21 to 24	20				29

NOTE: 1 TON = 2,240 LBS.

TABLE III.

TENSILE TESTS FOR WROUGHT IRON.

GRADE B.

Section.	Dimensions.	Tensile Strength, Tons per sq. in.	Minimum Elongation per cent.				Minimum Contraction of Area per cent. of Original Area.
			Test Piece B.		Test Piece F.		
	Diameters or Sides up to:—		As Rolled.	Turned Down.	As Rolled.	Turned Down.	
ROUNDS AND SQUARES.	$\frac{3}{8}$ in.	21 to 25	22	—	—	—	40
	$\frac{9}{16}$ in.	21 to 25	22	—	—	—	40
	$\frac{3}{4}$ in.	21 to 25	25	—	—	—	40
	1 in.	21 to 25	25	22	—	—	38
	1¼ ins.	21 to 25	25	22	31	27	38
	1½ ins.	21 to 25	24	22	30	26	36
	2 ins.	21 to 25	—	21	—	25	36
	2½ ins.	20 to 24	—	20	—	24	36
	3 ins.	20 to 24	—	19	—	23	34
	3½ ins.	20 to 24	—	18	—	22	34
	4 ins.	20 to 24	—	17	—	21	32
			Test Piece A.				
FLATS. NOTE. Flats over 1 inch thick shall comply with the tests applicable to a square bar having a side equal to the mean of the two adjacent sides of the Flat.	4 ins. wide and under, tested as rolled or machined to 1½ ins. wide × under $\frac{5}{16}$ in. thick	21 to 24	18				27
	Ditto × $\frac{5}{16}$ in. to under ½ in. thick	21 to 24	19				29
	Ditto × ½ in. thick and over up to 1 in. thick inclusive	21 to 24	20				31
	Over 4 ins. wide, tested as rolled or machined to 1½ ins. wide × ½ in. thick and under	21 to 24	18				27
	Ditto × over ½ in. thick up to and including 1 in. thick	21 to 24	19				29
ANGLES, TEES AND CHANNELS.	½ in. thick and under	21 to 24	15				22
	Over ½ in. thick	21 to 24	17				24
PLATES. With the grain.	½ in. to $\frac{7}{8}$ in. thick	20 to 24	12				—
	¾ in. to ⅞ in. thick	20 to 24	10				—
Across the grain.	½ in. to $\frac{7}{8}$ in. thick	17 to 21	4				—
	¾ in. to ⅞ in. thick	17 to 21	4				—

NOTE: 1 TON = 2,240 LBS.

TABLE IV.

TENSILE TESTS FOR WROUGHT IRON.

GRADE C.

Section.	Dimensions. Diameters or Sides up to:—	Tensile Strength, Tons per sq. in.	Minimum Elongation per cent. Test Piece B. As Rolled.	Test Piece B. Turned Down.	Test Piece F. As Rolled.	Test Piece F. Turned Down.
ROUNDS AND SQUARES.	3/8 in.	21 to 25	18	—	—	—
	9/16 in.	21 to 25	18	—	—	—
	3/4 in.	21 to 25	22	—	—	—
	1 in.	21 to 25	22	19	—	—
	1 1/4 ins.	21 to 25	22	19	26	23
	1 1/2 ins.	21 to 25	21	18	25	22
	2 ins.	21 to 25	—	17	—	21
	2 1/2 ins.	20 to 24	—	16	—	20
	3 ins.	20 to 24	—	15	—	19
	3 1/2 ins.	20 to 24	—	14	—	17
	4 ins.	20 to 24	—	13	—	15
			Test Piece A.			
FLATS. NOTE. Flats over 1 inch thick shall comply with the tests applicable to a square bar having a side equal to the mean of the two adjacent sides of the Flat.	4 ins. wide and under, tested as rolled or machined to 1 1/2 ins. wide × under 5/16 in. thick	21 to 25	14			
	Ditto × 5/16 in. to under 1/2 in. thick	21 to 25	15			
	Ditto × 1/2 in. thick and over up to 1 in. thick inclusive	20 to 24	16			
	Over 4 ins. wide, tested as rolled, or machined to 1 1/2 ins. wide × 1/2 in. thick and under	20 to 24	14			
	Ditto × over 1/2 in. thick up to and including 1 in. thick	20 to 24	15			
ANGLES, TEES, AND CHANNELS.	1/2 in. thick and under	21 to 25	12			
	Over 1/2 in. thick	20 to 24	14			
PLATES. With the grain.	1/4 in. to 5/8 in. thick	20 to 24	8			
	3/4 in. to 7/8 in. thick	20 to 24	8			
Across the grain.	1/4 in. to 5/8 in. thick	17 to 21	3			
	3/4 in. to 7/8 in. thick	17 to 21	3			

NOTE: 1 TON = 2,240 LBS.

TABLE V.

Conversion Table.

Tons.	Pounds.	Tons.	Pounds.
17	38,080	44	98,560
18	40,320	45	100,800
19	42,560	46	103,040
20	44,800	47	105,280
21	47,040	48	107,520
22	49,280	49	109,760
23	51,520	50	112,000
24	53,760	51	114,240
25	56,000	52	116,480
26	58,240	53	118,720
27	60,480	54	120,960
28	62,720	55	123,200
29	64,960	56	125,440
30	67,200	57	127,680
31	69,440	58	129,920
32	71,680	59	132,160
33	73,920	60	134,400
34	76,160	61	136,640
35	78,400	62	138,880
36	80,640	63	141,120
37	82,880	64	143,360
38	85,120	65	145,600
39	87,360	66	147,840
40	89,600	67	150,080
41	91,840	68	152,320
42	94,080	69	154,560
43	96,320	70	156,800

NOTE: 1 TON = 2,240 LBS.

APPENDICES.

FORMS

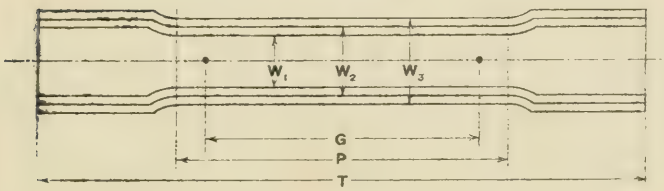
OF

BRITISH STANDARD TENSILE TEST PIECES.

APPENDIX.

FORMS
OF
BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

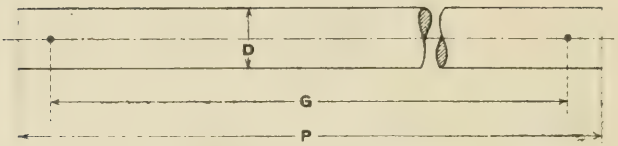


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches.
Total Length **T** = About 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.)	W_1 = 1$\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in. (0·875 in.)	W_2 = 2 ins.
Under $\frac{3}{8}$ in. (0·375 in.)	W_3 = 2$\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of 2 inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones: with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard Test piece of form **A.**

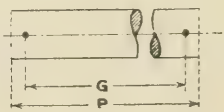
TEST PIECE **B.**



Gauge Length **G** to be not less than 8 times the diameter **D**.
With enlarged ends :—Parallel Length **P** to be not less than 9 times the reduced diameter **D**.

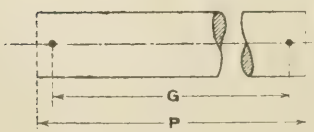
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A**, 8 inches in gauge length, 2 inches wide and $\frac{3}{8}$ inch thick.

TEST PIECE **C.**



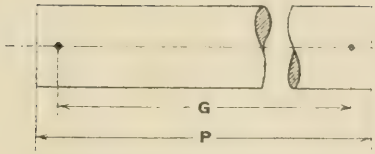
Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than $2\frac{1}{4}$ inches.
Dia. = 0·564 inch.
Area = $\frac{1}{4}$ sq. inch.

TEST PIECE **D.**



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than $3\frac{3}{8}$ inches.
Dia. = 0·798 inch.
Area = $\frac{1}{2}$ sq. inch.

TEST PIECE **E.**

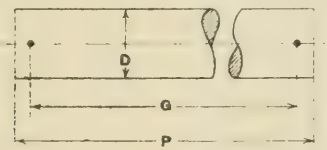


Gauge Length **G** = $3\frac{1}{2}$ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = $\frac{3}{4}$ sq. inch.

Test pieces **C, D** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either $\frac{1}{4}$ square inch or $\frac{1}{2}$ square inch in sectional area. With the gauge lengths decided upon, these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard Test Piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation.

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D**.
With enlarged ends:—Parallel Length **P** to be not less than $4\frac{1}{2}$ times the reduced diameter **D**.

In some testing machines it was found inconvenient to use form **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with Test Piece **F** is greater than with Test Piece **B,** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS.

In the case of the round test pieces **B, C, D, E** and **F,** the form of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

PRICE LIST

OF

BRITISH STANDARD SPECIFICATIONS AND REPORTS.

OCTOBER, 1919.

(This List cancels all previous Lists.)

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